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## The Role of PWC in Declaring a Diver Fit

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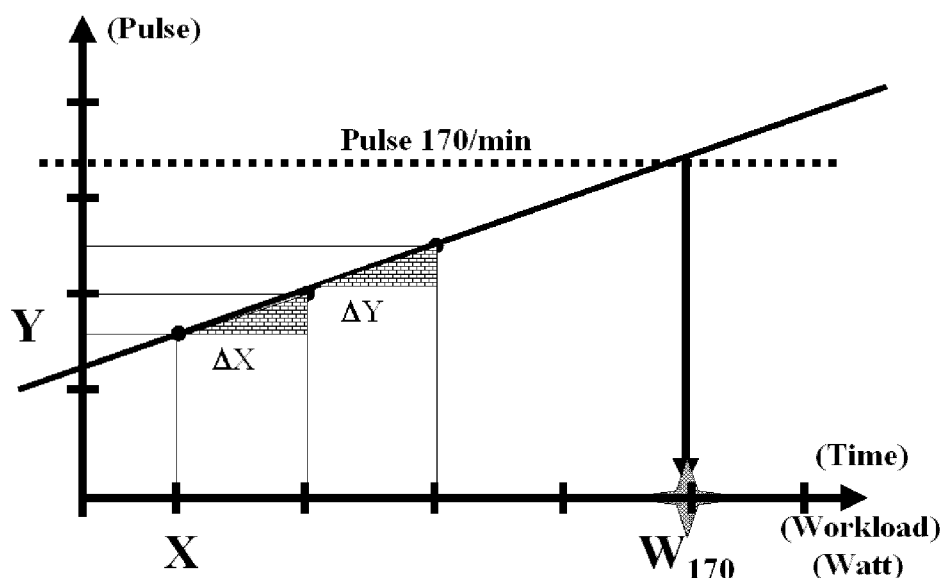
Keywords: Workload, Pulse, Habits, Gender, Fitness, Pulse-Working-Capacity

### Summary:

The relative pulse-working-capacity  $PWC_{170rel}$  is thought to represent the maximum workload which a person kann achieve with constant oxygen-uptake. The general mean of about 3 Watt/kg bodyweight depends on gender and fitness and to a low degree on age. With allowing all kinds of military tasks for women in the german forces it is likely that only women out of the upper regions of the standarddeviation of that special group will be chosen for demanding military tasks.

Under the condition of steady state the highest workload with a constant oxygen-uptake is called „working capacity“. It is accompanied by a heart frequency of 155 to 175 beats per minute and this is called Pulse-Working-Capacity, PWC. If you generally refer to 170 beats per minute then the corresponding workload is called  $PWC_{170}$ .

The method:



If a person is exposed to a workload of X Watt for a certain period of time on a bicycle then you can register a heartfrequency (Pulse) of Y beats per minute. Raising the workload by a certain amount will lead to a corresponding pulse. In a submaximal range the relation between workload and pulse is linear. The line of pulse-values can be extrapolated to the value of 170 beats per minute.

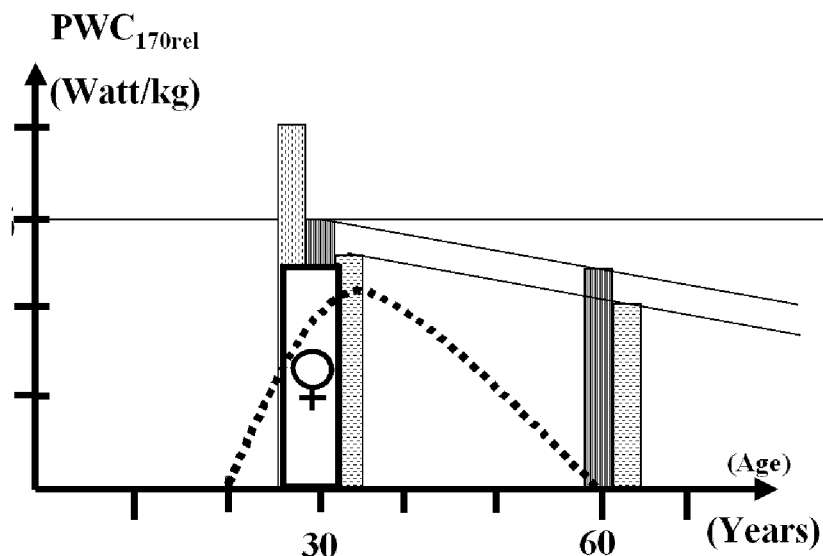
This is taken as representative for the working capacity and leads to a corresponding theoretical workload ( $W_{170}$ ).

Dividing this  $W_{170}$  by the bodyweight in kilogramm (kg) leads to the relative pulse-working-capacity,  $PWC_{170rel}$  and this is the subject I am speaking about.

For the young male person a mean-value of 3 Watt/kg with a standarddeviation of 0,4Watt/kg has been found. The principle of this method has been published as early as 1949 by Wahlund.

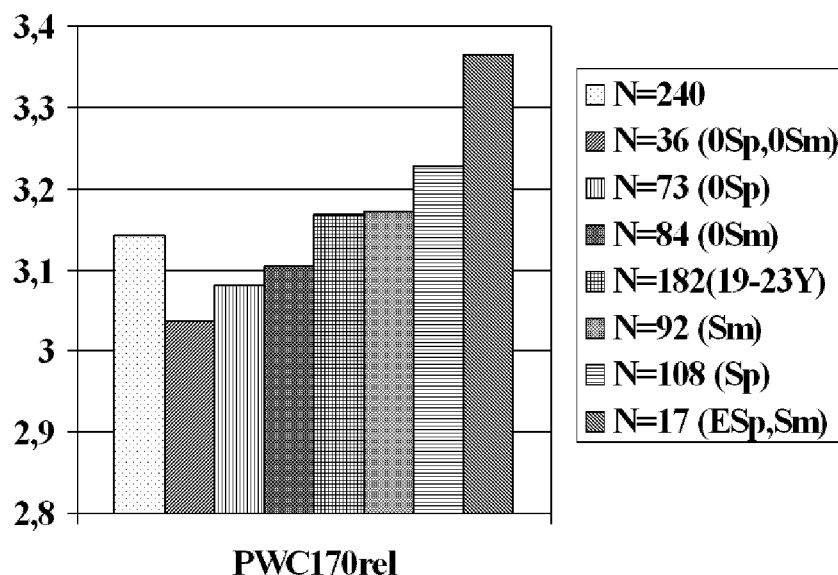
But the relative pulse working capacity 170 as a means to determine the muscular effectiveness of an individual, that is it's fitness, has been gradually added to our diagnostic tools in the early seventies.

The method is widespread since then but nevertheless it is not generally accepted and partly there have grown religious wars out of it.

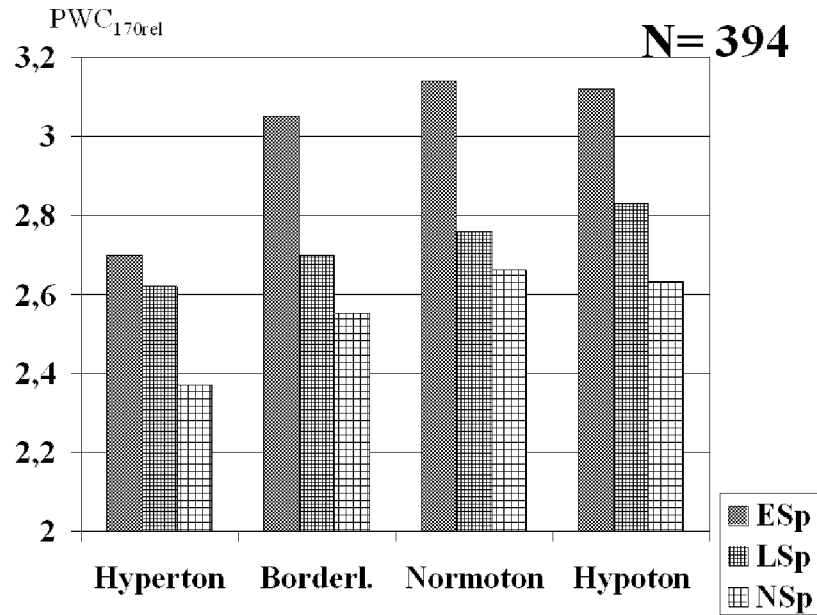


The duration of diving of a professional military diver lies between his 20<sup>th</sup> and his 60<sup>th</sup> year of life with more intensity in the earlier years. The scientific efforts to determine normal values lead to a relative pulse working capacity 170 of 3 Watt/kg for the young human being of about 30 years of age. Soon it became clear that the young females presented a value of 2,5 Watt/kg. (Our own female pressure chamber assistants showed a  $PWC_{170rel}$  of 2,3 Watt/kg) Well trained allround sportsmen presented a relative pulse working capacity 170 of 4 Watt/kg.

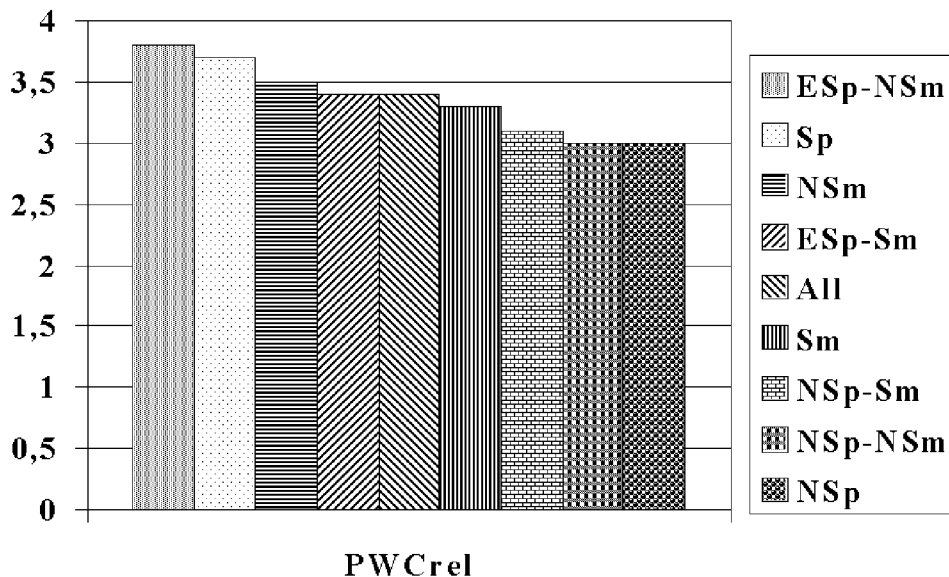
With growing age the relative pulse working capacity 170 becomes smaller, it is 0,2 Watt/kg per decade they say and publish. So it seems to be a generally accepted opinion that the young male person at the climax of his effectiveness has a relative pulse working capacity 170 of 3,0 Watt/kg and the female of 2,5 Watt/kg. Since then all is growing worse. So say the sportsreporters when they speak of the grand old ladies meaning those having just passed their twenties.



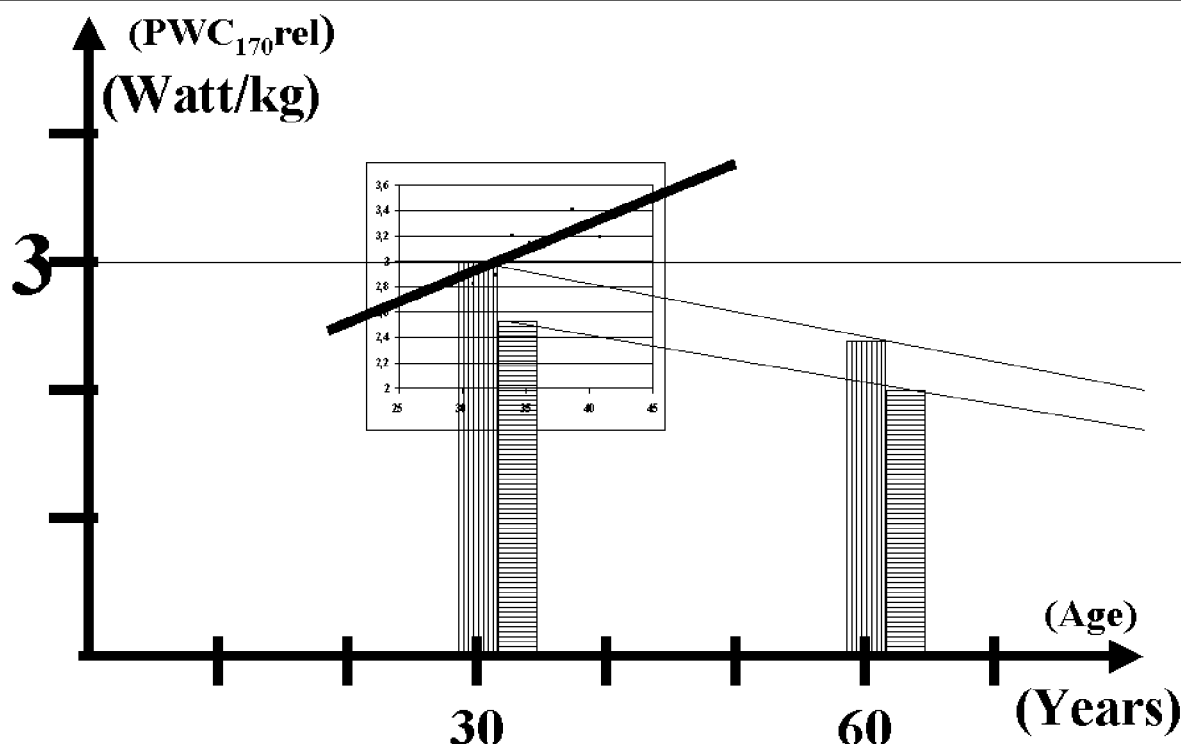
240 soldiers who have been considered fit for duty showed up in a forces hospital for different reasons. Some came because they did not really feel fit, some came to prolong their time in the forces others came for preventive reasons. These 240 soldiers were exposed to the determination of their relative pulse working capacity 170. This crowd could be subdivided according to the smoking habits and the sporting activity and the results were somehow surprising for me. The relative pulse working capacity 170 of all subcrowds was greater than 3,0 Watt/kg, that was considered to be rather good. The no-sport-group presented the lowest value as I suspected. The smoking sport-group presented the highest values which surprised me.



Out of 1200 ergometric examinations of a different forces hospital 394 were taken. This group was divided into the subgroups of hypertonic, borderlinehypertonic, normotonic and hypotonic patients who could either do endurance sport or little sport or no sport. Each subgroup had a relative pulse working capacity 170 smaller than 3,0 Watt/kg. Within the subgroups all endurance sportsmen had greater relative pulse working capacity 170 values than those with little or no activity in sports. The relative pulse working capacity 170 of the subgroup of hypertonic patients doing endurance sport was nearly as low as that of hypotonic patients doing no sport at all.



In the year of 1989 I tried to estimate the mean efficiency of dive-beginners before starting their training. They all were volunteers and I took only those who had a completely normal lungfunction and who ranged close around the mean of all examined divers with respect to length, weight and age. Out of 1200 divers I got 72, who fitted well to the above mentioned criteria. This whole group showed a relative pulse working capacity 170 of 3,4 Watt/kg. Smoking seemed to have no severe negative effect but it is rather satisfactory for physicians to see that not smoking sportsmen presented the highest relative pulse working capacity 170.



The published opinion that growing age has negative influence on relative pulse working capacity 170 cannot be confirmed by intraindividual longterm followup registrations. The analysis of those rather few soldiers who have been repeatedly controlled over up to more than twenty years partly till the age of 55 years shows that the relative pulse working capacity 170 -value is growing to an individual climax between the 30<sup>th</sup> and 60<sup>th</sup> year of age. Values of 2,6 Watt/kg at the beginning of registration do not prevent the individuals to reach values of more than 3 Watt/kg. An age of more than 40 years does not prevent values of up to 4 Watt/kg and the latter are values typically found with trained allround sportsmen. Nevertheless these findings are not very surprising because the soldier whose longterm profession is diving gets additional money as long as he is employed as a diver. Standard of living and family situation depend on the money earned. Therefore he is eager to stay fit and the result of this eagerness seems to be a high or growing relative pulse working capacity 170.

To summarize:

the healthy young man has a mean-relative pulse working capacity 170 of 3,0 Watt/kg, the young woman has a mean-value of 2,5 Watt/kg, those are the published normal values.

State of training or efficiency seem to be linked to relative pulse working capacity 170 -values in the way that high PWC-values allow to suppose good trainingstatus and/or good efficiency.

In the military everyday task the minimum requirements for personal efficiency do not depend on that what a soldier is able to achieve but on that what the task demands. If in this respect the minimum requirement for male efficiency is a relative pulse working capacity 170 of more than 2,2 Watt/kg then the same value must be demanded from women. As a consequence out of their group only those will be chosen who do not show values less than one single standarddeviation below the mean of the female group.

As since the end of this year the forces regulations will allow women to join every task in the forces they are fit for some of them likely will try to become mineclearance divers or attackswimmers.

For them a minimum relative pulse working capacity 170 -value of more than 2,6 Watt/kg will be mandatory as for their male competitors.

This value is higher than the mean for healthy women in general.

Abbreviations: 0Sp; NSp= no sports, Esp= endurancesports, LSp= little sports  
 0Sm; NSm= no smoker Sm= smoker Y= years